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Evaluating the Potential of some of the Terrestrial Bacterium for Biodegrading and Reducing the Solanine in the Potato Remainders (Case Study: Soil Biology)

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ABSTRACT

According to this fact that about 40 percent of agricultural crops, which are produced by the photosynthesis during a year, are considered as the byproducts and since the annual biological stabilization capacity of carbon throughout the world has been 85,000 tons, the microbial decomposition of cellulose and hemicellulose has been so important in order to balance the carbon cycle. Ruminants can be the proper consumers for byproducts due to having a special enzyme "Cellulase" in their digestive system. However, several compounds, which are used as the animals feed, are the rich sources of fiber and also some of them contain the anti-nutritional compounds which cause abnormalities in animals by a variety of ways. Solanine in the remainders of potatoes is one of the anti-nutrients compounds. Soil is a dynamic environment, and the useful actions such as reducing the toxic substances in the agricultural remainders can be done by using some of the bacterium, fungi and its other residents; and this important action can be done with the help of soil biologists. In this study, it has been tried to reduce the Solanine, increase the protein, decrease the ratio of carbon to nitrogen in the potato remainders, and making it delicious for livestock using three bacterium of soil. All three species of bacterium were successful in biodegrading the potato remainders and the results will be provided as detail in the Conclusion.
KEYWORDS: Solanine; terrestrial bacterium; biodegradation.

INTRODUCTION

Unfortunately, half of the agricultural and forest products as the byproducts and organic remainders are useless. These remainders have a significant weight amount and sometimes are burned or destroyed by farmers because of their lack of knowledge about the consuming way. But every remainder can be a good source for animal feed or producing the organic and biological fertilizers. Due to this fact that Iran is a dry and low rainfall country with an average annual rainfall about 250 mm, high organic matter in various economic sectors are needed. In the agriculture sector, the organic remainders can be used for making the organic fertilizers or they can be used in the animal Husbandry with proper management. It has been passed a long time which researchers have tried to benefit from these agricultural remainders. Because only the carbon of herbal molecules can be a good alternative for the fossil carbons based on the energizing factor and combination with the other atoms.

However, several compounds, which are used as the animal feed, are the rich sources of fiber, and also the others contain the anti-nutritional compounds which are ineffective not only in raising the livestock, but also they can cause abnormalities in animals by various ways. These compounds are called anti-nutritional compounds. For this reason, some of the farmers burn these remainders; and this action destroys these valuable organic fertilizers and causes the air pollution.

Reusing the wastes and agricultural byproducts is inevitable due to the ecological and economic pressures. Byproducts should be considered as the valuable raw materials which can cause environmental pollution if they are not applied. In fact, utilization of wastes and agricultural byproducts is changing to an economic duty for eliminating the shortage of raw and energetic materials on one hand, and resolving the ecological problems on the other hand. Therefore, it can be expressed that the successful recycling of wastes will give them the gold worth (Daraygar, 2001).

The agricultural remainders account for a large part of organic food needed for the agriculture saprophagous organisms. The herbal remainders are created in the extremely large amount in the forest and agricultural lands. It has been estimated that approximately 155 billion tons Lignocellulose are made annually on Earth by the photosynthesis process; of which nearly two-thirds occur in the lands and one-third in the oceans. Large amount of 65% emerged Lignocellulose is made in lands, forests, woods (Daraygar, 2001). In planting most of the plants on farms, just a small part of plant such as its seed or fruit are harvested and the left parts will remain on the soil (Safari Sanjani, 1379).

One of the major products of the Hamedan province is the potato which its remainders is mostly burned after harvesting the glands, and it is not used in the Hamadan region. Small groups of farmers, who have the special

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agricultural implements, give back those remainders again to the soil. On the other hand, due to the anti-nutrients in potato, it cannot be utilized as the animal feed in ruminants (Janjan, 1384). One of the compounds in the potato remainders is the non-protein nitrogen compounds, including the Alkaloids such as the Solanine, which are free or have the form of Glycoalkaloids combinations such as the Chaconine and Solanine. Solanidine and its derivatives are toxic for the man and animals (In large amount) and cause the stomach and intestines inflammation. Dilatation of liver, infertility, skin inflammation, and abdominal pain are the harms which are caused by the Solanine in humans and animals. The safe level of Glycoalkaloids for human consumption is 1 milligram per kilogram of body weight.

This study was continued by two goals: 1- Evaluating the potential of bacterium in biodegrading the potato remainders; 2- detecting the best bacteria for reducing the Solanine of potato remainders.

MATERIALS AND METHODS

This study has three treatments for bacteria, the potato remainders, and one evidence (potato remainders without adding the bacteria), and has been implemented by three replications in a completely randomized plan as follows. The potato remainders from the Agria type (which is the dominant planting of region) were collected after harvesting in Shahrivar, and then they were threshed and grinded to the size 2 mm which is a good field for the growth of bacterium.

Three types of terrestrial bacterium were used in this study: 1. *Bacillus Lentus bacteria*; 2. *Bacillus with unknown species;* 3. *Pseudomonas putida*.

After purchasing the bacterium from the Industrial Research Center in Tehran, the solid prepared culture of nutrient agar (N.A) was utilized in order to multiply each of the test bacteria and ensure their purity; also the necessary tests such as the Gram stain, checking the appearance under the microscope, and forming the spores were done. While inoculating for rejuvenation, the bacterium was re-cultured. And then for reproducing the bacterium, the nutrient Bruce (N.B) medium was used so that a million bacteria are available per ml of medium.

Before sterilizing the agricultural remainders, their moisture was reached to the FC level and then each of them was sterilized for two days and every 15 minutes at 121 ° C in Autoklav. After sterilizing the remainders, one cc of each bacterium in the liquid medium was vibrated in the test tube and inoculated to the medium of potato remainders. After the inoculation of remainders, they were stored for 30 days, and in this period the remainders were watered at the same reduced amount of water. The amount of Solanine in the potato remainders before and after the incubation was determined using the Hadadchi-Gholamreza method (Hadadchi, 1365). In addition, the percentage of organic carbon was determined before and after 30 days by dry incineration in kiln at a temperature of 550 ° C and after 5 hours (Parvaneh, 1376). The percentage of total Nitrogen was measured by the Kjeldahl method and at the mentioned times (Parvaneh, 1376).

RESULTS AND DISCUSSION

Table 1 indicates that the bacterium at the statistical level 5% have a significant effect on reducing the amount of Solanine in the potato remainders. The amount of Solanine in the potato remainders has been 0.052 g in one gram before treatment with bacterium and it has been reduced significantly by bacterium after 30 days. According to the Table 2, the highest rate of Solanine biodegradation has been done by the *Bacillus* bacteria and the amount of Solanine in the potato remainders has been reduced to 0.0016 after treatment with this bacterium. As Table 2 shows, all treatments with bacteria have had the significant difference statistically with the evidence, but they have the same potential themselves. Moreover, Table 1 shows that the bacterium at the level 5% have had a significant effect on reducing the carbon to nitrogen ratio ($\frac{C}{N}$) of potato remainders; and this reduction is one of the signs of degradation the lignocellulytic compounds in the potato remainders. According to the Table 2, the carbon to nitrogen ratio of potato remainders has been 23.53 before the treatment with bacteria and it has been reduced significantly after 30 days and based on the Table 2, it has been reached to 13.55 by treatment with *Bacillus Lentus* bacteria. The mean comparison Table (No.2) indicates that all bacteria have had the potential to reduce the carbon to nitrogen ratio, and they have had significant difference at statistical level 5% compared with the evidence (without bacterial treatment), but the bacterium themselves have not been significantly dissimilar.

Table 1 indicates that bacterium have a significant effect on increasing the percentage of protein in the potato remainders. The percentage of protein in the potato remainders is 11.67 before treatment with bacteria and it has been increased significantly by bacterium at level5% after 30 days. The mean comparison Table (No.2) indicates that all bacteria have had the potential to increase the percentage of proteins in the potato remainders and they have had remarkably different potentials at statistical level 5%. The highest protein increase percentage has been done by Bacillus Lentus bacteria, and the lowest protein increase done by the

Pseudomonas putida bacteria. According to the results of test, all bacterium can reduce the Solanine and increase the protein in the potato remainders. Therefore, the potato remainders which are treated with bacteria especially *Bacillus Lentus* bacteria can probably be utilized for preparing the animal feed, compost fertilizer, biological fertilizers, or ruminants feed ration.

Table 1- ANOVA of the effect of bacteria on the biodegradation of potato remainders

Parameter	Source of changes	Degree of freedom	Sum of squares	Mean Squared	F	P
Solanine	Treatment	3	0.00562	0.00187	67.38	0.0001 **
	Error	8	0.0002226	0.00002784		
	Total	**11**	**0.005849**			
Carbon to Nitrogen ratio ($\frac{C}{N}$)	Treatment	3	176.9421	58.98		
	Error	8	27.4018	3.426	17.21	0.0008**
	Total	**11**	**204.352**			
Percentage of protein	Treatment	3	54.224	18.075		
	Error	8	6.102	0.763	23.69	0.0002**
	Total	**11**	**60.327**			

Table 2- Comparing the ability of bacteria in biodegradation of potato remainders

Treatment	Solanine (g per g)		Carbon to Nitrogen ratio ($\frac{C}{N}$)		Percentage of protein	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Evidence	0.052 a	0.01053	23.53 a	0.1892	11.67 c	0.680
Bacillus Lentus	0.0017 b	0.00010	13.55 b	0.2893	17.226 a	0.746
Bacillus S. P.	0.0016 b	0.000058	14.92 b	0.5103	16.370 a	1.167
Pseudomonas Putida	0.0026 b	0.00058	16.58 b	3.6503	14.576 b	1.062

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